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## **HISTORICAL DEVELOPMENT OF THE AUSTRALIAN MINERAL INDUSTRY**

(This article has been contributed by the Bureau of Mineral Resources - written by I. R. McLeod)

The history of the Australian mineral industry began with the first European settlement when settlers quarried stone and dug clay for bricks for their buildings. The industry since then has had its booms and depressions, but from the discovery of gold at least, it has been an important contributor to the Australian economy. It provides the nation's basic industrial requirements - construction materials, fuel, and industrial raw materials; it has facilitated decentralisation of both population and industry, as towns, railways and ports were established to serve the mines and smelters; it has encouraged technological advancement, both in its own and other, unrelated, fields; and it has been a major earner of export income.

The industry has created wealth for the nation and its people through the discovery and mining of mineral deposits and processing the ore. It now produces some 65 different mineral commodities with an annual value of mine production ranging up to more than \$5,000 million in the case of coal. Australia is one of the world's leading miners of bauxite (the ore of aluminium), diamonds, gold, iron ore, lead, manganese ore, nickel, titanium (rutile and ilmenite), tungsten, zinc and zircon. It mines, or has unworked deposits of, almost all mineral commodities - of the major mineral raw materials it now lacks only sulfur. Some commodities, such as petroleum and aluminium, have had a relatively short production history in Australia; others, such as the base metals, iron ore, and, especially, coal, go back to the early days of the industry.

### **AUSTRALIAN ECONOMIC DEMONSTRATED RESOURCES, MAJOR MINERAL COMMODITIES** (Mt unless otherwise indicated)

Commodity	Pre 1965(a)	1975	1985
Bauxite	21(1954)	3,000	2,889
Black coal (recoverable)	(b)4,276(1962)	19,500	34,000
Brown coal (recoverable)	17,000(1960)	12,600	41,900
Copper (kt)	1,300(1960)	5,900	16,100
Diamond ( $10^6$ carat)			
gem	-	-	187
industrial	-	-	229
Gold (t)	250(1960)	156	959

Iron ore	374(1959)	17,800	16,220
Lead (kt)	4,300(1960)	13,900	14,500
Manganese ore	<2(1962)	490	326
Nickel (kt)	-	1,900	1,700
Petroleum ( 10 <sup>6</sup> m <sup>3</sup> )			
crude oil	-	243	231
natural gas	-	326,100	691,000
Silver (kt)	7(1960)	24	31
Tin (kt)	(c)28(1960)	(c)332	262
Titanium (concentrate)			
ilmenite (kt)	(d)3,500(1955)	58,400	41,400
rutile (kt)	2,500(1955)	9,200	8,000
Uranium (recoverable) (kt)	n.a.	300	470
Zinc (kt)	4,000(1960)	19,300	21,200
Zircon (kt) (concentrate)	2,900(1955)	15,700	11,500

(a) Only partly on same basis as later years.

(b) Excludes Victoria, where reserves were small. Not specified whether in situ or recoverable.

(c) Recoverable; in situ resources estimated to be about 20 per cent higher.

(d) Not suitable for pigment production. Source: Bureau of Mineral Resources.

## Coal

It is not surprising that coal was the first mineral, other than those used for construction, to be found, because seams crop out along the coast to the north and south of Sydney. Coal was first discovered in the Newcastle area by escaped convicts in 1791. Mining began near Newcastle in 1799, and in 1800 coal became the first mineral exported from Australia.

Production increased steadily from the 1830s onwards, and in the mid-1920s Australian production was almost 14 Mt, but the depression of the 1930s saw it fall by over a third of this amount. Renewed growth faltered in the late 1940s. Exports, which normally exceeded 1 Mt/year until the mid-1920s, had fallen to about 50,000 t by the late 1940s because of increasing competition. At that time also, petroleum products began to replace coal in industry and railways, and these trends were exacerbated by prolonged industrial unrest.

It was widely agreed then that coal would be of diminishing importance as a major mineral commodity. However, measures taken to improve the efficiency of mining, realisation of the economic importance of near-surface seams in the Bowen Basin in Queensland, and the emergence of large markets for coking coal in Japan particularly, brought about a resurgence in the industry. Exports began to increase rapidly in the mid-1950s, and, with impetus added by the oil shocks of the 1970s, Australia became the world's largest coal exporter, with exports reaching 88 Mt in 1985.

The pattern of production changed also. In 1950, New South Wales provided 75% of the total production and Queensland, 14%. In 1985, the two States provided 47% and 49% respectively, and exports from the two were about equal, 68% of the total Australian production being exported. Despite its changing fortunes, the coal industry has been a major sector of the mineral industry for 150 years. The rapid increase in exports in the 1960s consolidated its pre-eminence; in 1985 coal contributed 24% of the total value of ex-mine production in Australia, represented about a third of the industry's total assets, and provided 16% of total Australian merchandise exports.

## Minerals

In the circumstances at the time, the early settlers were little interested in minerals. Traces of gold were reported from 1823 onwards, and occurrences of other metals were reported from time

to time. The first metalliferous mining was of silver-lead, at Glen Osmond near Adelaide, in 1841. Copper mining began at Kapunda, in the same general area, in 1842, and at Burra, to the north, in 1844. At the end of the same decade, the first pig iron was produced from a small deposit of iron ore near Mittagong, New South Wales.

It was the discovery of payable alluvial gold in 1851 near Bathurst in New South Wales and, soon after, the rich Victorian fields, that gave impetus to the metalliferous sector of the mineral industry. As search and discovery quickly spread to other parts of eastern Australia, the migrants which the gold attracted, the infrastructure which resulted, and realisation of the mineral potential of the young country, all profoundly influenced the development of Australia from the 1850s onwards.

The wealth created by the newly-mined gold and the influx of migrants began the transition away from an agricultural and pastoral economy. As industries were established to supply the machinery and transport facilities needed by the mines, service industries expanded to cater for increasing population and growing commercial activities.

Gold was the prospectors' prime target for many years after 1851, and the Victorian discoveries were followed by many others around the continent, though few were so rich. Many of the new gold-fields were abandoned as the shallow surface alluvials were exhausted, but on some, especially in Victoria, mining progressed to the deep leads -- alluvial deposits covered by tens of metres of later sediments or by lava flows.

Prospecting on some fields discovered primary gold lodes rich enough to be worked. But working such lodes necessitated deep shafts and machinery and treatment plants, and these required capital. The individual miner or syndicate was replaced by companies, employing dozens or even hundreds of men. Towns were established and, as confidence in the long life of the mines increased, tents and shanties gave way to more permanent private and commercial buildings. When, decades later, the mines did start to peter out, many such towns survived because they had become centres for the surrounding agricultural and pastoral industries, or were at convenient points on well established transport routes.

The interest and expertise in prospecting aroused by gold soon led to discoveries of other metals. Tin mining began almost simultaneously in 1872 at Inverell, New South Wales, Mount Bischoff, Tasmania, and Stanthorpe, Queensland. With the discovery soon after of other fields, especially Herberton in North Queensland, Australia became the major world source of tin in the late 1870s and early 1880s. Base metals were discovered at many places, including Moonta-Wallaroo, South Australia, Zeehan-Dundas and Mount Lyell, Tasmania and Cobar, New South Wales, and Mount Morgan, Queensland. The fabulous Broken Hill lode, whose profits spawned a variety of industries, including steel at Newcastle in 1915, was discovered in 1883.

By the beginning of the twentieth century, the metalliferous mining industry, with associated smelters and refineries, was well established. Gold was still pre-eminent, accounting for three quarters of the total value of metalliferous mine production, with copper, lead and silver accounting for most of the remaining quarter.

Like the goldfields, each mine needed a town for its workers, engineering and machinery suppliers and transport facilities - including ports to ship its products to other parts of the world. Many towns in existence today owe their foundation to a mineral deposit found in the last four decades of the nineteenth century.

The industry continued to prosper in the early years of the twentieth century. However, it was severely affected by the collapse of metal prices after the ending of World War I. Many mines closed, and the value of mineral exports fell from \$15.3 million in 1919-20 to \$7.6 million in 1921-22.

In the late 1930s the mineral industry, although well established, played a minor role in the Australian economy. The need for new ore reserves of many minerals was the major concern of the industry in the late 1930s and early 1940s. Indeed, the forty-year drought of new discoveries, after the flood of the previous century, led some to the belief that there were few new resources to be found, and that the industry would gradually run down. An embargo was placed on the export of iron ore in 1938 by the Commonwealth Government, when reserves of high-grade ore were believed to be no more than 260 Mt. Few new mineral deposits were found from the beginning of the century until after World War II.

In the late 1940s there began a series of discoveries that was to completely change the structure of the industry and elevate Australia to a major mineral exporting country. In the 1950s the mainstays of the industry were lead, zinc, copper, gold, and coal, and only the first four were exported in any quantity. By the late 1960s Australia was a world force in aluminium, coal, iron ore, nickel, manganese, titanium, uranium and zirconium as well as the traditional lead and zinc.

The reason for the surge of discoveries is manifold. Some of the 'new' deposits had been known previously, but were not economically workable. The economics of working such deposits changed remarkably because of technological advances which lowered the cost of mining and transporting huge quantities of material, but these advances would not have been decisive without the emergence of Japan as a major buyer of coal, iron ore and bauxite.

The discovery of new ore bodies close to former mines and the striking of the many new deposits was aided by the development of geochemical and geophysical exploration methods suited to Australian conditions. Many techniques developed in the northern hemisphere were not successful in the arid, deeply weathered terrain characteristic of most of Australia.

However, these techniques were modified and new ones developed, and Australia is now a world leader in expertise for mineral exploration in arid regions.

Apart from Japan's economic growth, the expansion of the world economy in the 1950s and 1960s meant an ever increasing demand for minerals. Australia, with its well established industry, had the experience needed to find and develop the new deposits needed to meet this demand.

The greatly increased knowledge of the geology of Australia resulting from systematic geological and geophysical studies led to a better understanding of the geological evolution of the continent. Mineral explorers were able to search more efficiently by using geological theories on the origin of mineral deposits to target specific areas for concentrated exploration. The better understanding showed also that Australia had a high potential for the discovery of mineral deposits. This realisation, together with Australia's political stability, led to an influx in the early 1960s of major overseas mining companies who, in addition to increasing exploration expenditure, brought in new expertise and ideas.

The search for a variety of minerals in diverse geological conditions has developed a highly experienced mineral exploration industry which has begun exporting its skills to other parts of the world.

## Petroleum

The 1960s saw also the discovery of economic accumulations of what had been Australia's most serious mineral deficiency - petroleum.

Although it had been sought for many years, petroleum (which includes crude oil and natural gas) was a latecomer to the mineral production scene in Australia. However, it has made up for lost

time and has become one of Australia's major mineral products in terms of value of production; and in 1985, following a change in government policy on petroleum exports, it was Australia's second most valuable mineral export.

Hydrocarbons, in the form of crude bitumen, were first recorded in 1839, at the mouth of the Victoria River, near the Western Australia-Northern Territory border. The first well drilled specifically for petroleum was put down in 1882 at Alfred Flat, in the Coorong area of South Australia. However this well, and several others in the same general area, did not encounter any oil.

In 1900, at Roma in Queensland, natural gas was encountered in an artesian water bore which was being deepened. Gas continued to flow freely from the well and in 1906 it was reticulated for town lighting; however, the flow failed after 10 days. This discovery marks the real beginning of petroleum exploration in Australia. Many wells were drilled subsequently in the Roma region; some encountered small quantities of oil or gas.

The first substantial flow of oil was in 1953 from the Rough Range No. 1 well in the north-west of Western Australia. However, a commercial field did not eventuate, and the interest in petroleum exploration aroused by the discovery began to wane. Because of the economic and strategic advantages of an indigenous supply of petroleum, the Commonwealth Government had encouraged the search for it since soon after World War I. With the increasing importance of petroleum and petroleum products to the Australian economy, the Government in 1957 adopted several measures, including a subsidy for specific approved operations, to encourage petroleum exploration. These measures did much to re-encourage exploration.

Australia's first commercial oil field was discovered at Moonie, 200 km south-east of Roma, in 1961. A pipeline was built to Brisbane, and commercial production began in 1964. 1964 marked several other important events: the discovery of oil and gas at Barrow Island, Western Australia; of gas in what has become a cluster of oil and gas fields in north-west South Australia and the adjoining part of Queensland; and the most important of all, the discovery of gas some 25 km off the Gippsland coast in Australia's first offshore well. The Gippsland shelf fields now supply three quarters of the crude oil and nearly half of the natural gas produced in Australia.

The Gippsland Shelf discovery, as well as becoming Australia's main source of oil and gas, also turned attention to Australia's extensive continental shelf, and 1971 saw the discovery of the huge gas fields of the North West Shelf which, in addition to supplying Western Australia, will begin to feed one of the world's few liquefied natural gas export projects at the end of the 1980s.

In the early 1970s, petroleum exploration again began to languish - indications from exploration were that onshore oilfields probably would be small and hence unlikely to be economic. However, the oil shocks of 1973 and 1979, when oil prices increased several-fold, completely changed the economics of the industry. Expenditure on exploration increased rapidly, from \$49 million in 1976 to \$948 million in 1982. Some known fields, such as Palm Valley and some Bass Strait fields, were developed, and many new fields were discovered, especially in south-west Queensland and the adjoining part of South Australia.

While exploration has been primarily for oil, it has discovered large resources of natural gas. Indeed, indications are that geological conditions in Australia in the past have favoured the formation of gas rather than oil. Natural gas contributed 19 per cent of total Australian energy consumption in 1985.

Most Australian crude oils are 'light', and oil still has to be imported to supply heavy fractions needed for lubricating oils, bitumen, etc. In 1985, 96 per cent of Australia's crude oil requirement was met by domestic production. However, unless major new discoveries are made, Australia's crude oil self sufficiency will begin to decrease as production from some existing fields declines.

Natural gas supplies, however, are adequate for many years, although resources are unevenly distributed around the continent.

## Twenty years of growth

In the mid-1960s, the Australian mineral industry began to expand with growth in both production and exports and the relative importance of the various commodities changed. The relative importance of gold and the base metals declined, while coal, iron ore and 'other minerals' increased in relative importance.

In 1965, industry spent \$22 million on mineral exploration, and \$48 million on petroleum exploration. These amounts had increased to peaks of \$576 million in 1981-82 on mineral exploration, and \$948 million in 1982 on petroleum exploration. Allowing for inflation these peaks represent a multiplication of exploration effort of seven times for minerals and five times for petroleum.

The Australian manufacturing industry, despite its growth, absorbed only a small part of the greatly increased mineral production, and the proportion of production exported (in either raw or processed form) increased greatly in the late 1960s and early 1970s. The index of mineral output at constant prices for 1985 was almost 6 times that for 1965, while the 1985 index of exports of metals and minerals at constant prices was over 11 times the 1965 figure. These exports relieved the pressure on the Australian balance of payments but also made the industry dependent on the health of the world economy.

The destination of exports changed between 1965 and 1985. In 1965, 41% of Australia's mineral exports went to Europe (and 24% of total exports were to the United Kingdom); 41% went to Asia (32% of the total going to Japan); and 16% went to America. In 1985, the corresponding figures were 14% (4%); 63% (41%); and 12%. In 1985 mining, smelting and petroleum production contributed 8% of the Australian GNP, was responsible for 16% of private fixed capital expenditure, and employed 132,000 persons.

In the early 1980s, lower mineral prices resulting from decreased world demand for minerals caused a drastic decline in the Australian industry's profitability; which was only 2.2 per cent of shareholders funds in 1981-82. Measures to increase efficiency, including mining higher grade ores, work-force reductions and changed work practices, and, in a number of cases, mine closures, had their effect, and by 1985-86 the return on shareholders funds had increased to 4.9 per cent.

Australia is now the world's first, second or third largest exporter of about 10 mineral commodities (including alumina, coal, iron ore, lead, nickel, mineral sands - rutile ilmenite and zircon - and zinc) and a major exporter of many others.

The Australian mineral industry is almost all owned and operated by the private sector. For much of the industry's history the relationship between it and government generally had been simple: State governments granted mining leases, ensured that the mining laws were observed, and collected royalties; the Commonwealth Government collected those taxes to which it was entitled.

Many of the new mines were planned as large scale operations from the very beginning. They needed a large workforce - which had to be housed and provided with community services -- and transport facilities to handle millions of tonnes of product each year. Rather than provide these facilities themselves, governments made it a condition of many new mining leases that the companies provided, or made a major financial contribution to, the infrastructure for the mining operation - not only the railways and ports, but the social infrastructure such as streets, houses,

schools, hospitals and recreation facilities.

This requirement arose partly because governments had difficulty finding the funds required because of competing demands in a time of rapid economic expansion; but another argument was that, because the mineral deposits belonged to the State, the benefits of their exploitation should go to the public generally as well as the companies concerned. Some governments took this argument further, and made the industry a source of revenue additional to the relatively small amount of royalty payments by imposing charges for services (e.g. rail freights) considerably higher than the cost of providing the service.

## **Environmental issues**

In the 1950s the industry began to be affected by increasing public concern for the quality of the environment. With the rising awareness that preservation of natural features such as scenery and plant and animal habitats had a value to society, governments increased the controls on discharge of potentially polluting emissions such as water containing sediments or chemicals, and noxious gases. Whereas the industry once, by and large, had priority in land use, it now had to justify its activities in competition with other potential uses of the land. Governments also took account of the likely effect of a proposed mining or treatment process on the surroundings before deciding whether it should go ahead, and required that, where feasible, mined-out areas be rehabilitated by reshaping and revegetating the surface so that the site could be used for other purposes.

The mineral industry's former priority for land use was eroded further in the 1970s when title to extensive tracts of land in the Northern Territory and some States was granted to the land's traditional Aboriginal owners. One result of this was that companies had to obtain the consent of the Aboriginal owners before they could explore or mine on such land. Because of the significance of land to Aboriginal society, and because of the owners' wish to minimise the effect of a different culture on their traditional way of life, this requirement commonly required prolonged negotiations and this in turn added to the costs and uncertainty of the mineral exploration process.

## **The industry today**

In the late 1970s, the rate of growth of the mineral industry in Australia, which had been maintained for more than 15 years, began to slow. New mines had been developed around the world to meet a forecast demand for minerals which turned out to be overly optimistic. The Australian industry's costs had increased but, in general, mineral prices had not. The industry was largely dependent on exports and had to compete for sales with mines in other countries; some of these mines were less affected by cost increases, or were assisted in various ways by their governments.

Many new coal mines were established in Australia after the second oil shock in 1979, but world demand stagnated, leaving the industry in Australia (and the world) with substantial surplus capacity. Metal prices failed to increase in line with the world economic upturn in the early 1980s, and few new metal mines were opened -- Australian production increased largely because of capacity increases at existing mines to achieve economies of scale. Statistics show mine production and exports increased year after year, but the return on funds employed generally was low and a number of mines closed because they had become uneconomic. Petroleum exploration expenditure had increased rapidly after the second oil shock in 1979; several new commercial fields were discovered, especially in south-west Queensland, and, because of the greatly increased price of crude oil, decisions were made to develop some previously uneconomic fields. However, the collapse of world crude oil prices in the first quarter of 1986

completely changed the fortunes of the petroleum industry. Production fell (mainly because of virtual cessation of exports), exploration was reduced sharply, and development of a number of fields was deferred.

At the exploration stage, the industry has to meet new challenges. Not surprisingly, the mineral deposits found in the first century of mineral search were those well exposed at the surface; and the first petroleum accumulations found tended to be the larger, better delineated, ones. Consequently, finding further economic ore bodies and petroleum accumulations has become progressively more difficult, requiring the use of increased skills in applying suitable methods and interpreting the results.

By the mid-1980s, one of the few bright spots in the Australian mineral industry was gold. Because its price was fixed, gold was largely ignored in the expansion of the industry after World War II. Interest revived to some extent when the price was freed in 1968 and strengthened with increasing confidence that the price increases of the late 1970s were likely to be sustained.

Two other factors heightened the interest. One was the development of an efficient method of recovering very fine grained gold; the other was the realisation that modern methods allowed the economic mining by open cut and treatment of an entire zone of gold bearing veins (both the veins and the intervening barren rock) whereas in the past only the veins themselves would have been mined.

So another gold mining boom emerged in the early 1980s. Australian gold production multiplied from 18 t in 1981 to 57 t in 1985. In 1984 and 1985 alone, 24 new gold mines were opened, and retreatment of old tailings began at several centres. Notably, almost all the deposits opened up were close to, or at, old mines - very few were completely new discoveries.

History probably will show that the 1980s was another period of change for the mining industry: a period of consolidation rather than expansion, especially in the structure of the industry, even though the volume of production continued to increase; a period of increasing diversity of export markets, with reduced dependence on a few major customers; a period of strenuous efforts to improve the efficiency of operations; and a period in which the Australian industry, despite far-reaching changes in world mineral production and consumption patterns, was able to retain its role as a major supplier to international markets, and a major source of income for the Australian economy.

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